

EGS Abstract for Nice, 2000

THE GRAVITY FIELDS AND INTERIOR STRUCTURES OF THE GALILEAN SATELLITES

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We report Galilean satellite results from a Gravity Science Investigation on the Galileo Primary Mission and on the Galileo Europa Mission. This includes, in addition to the analysis of radio Doppler data on separate satellite encounters, the results from a combination of all useful radio Doppler data, along with ground based astrometric data on the positions of the four satellites, and optical navigational data from the Voyager and Galileo Missions. We find that Io has a large metallic core, comprising as much as 52% of Io's radius, surrounded by a rock mantle. Similarly, a metallic core in Europa could be as large as about 50% of the radius, such that Europa is most likely differentiated into a metallic core surrounded by a rock mantle, like Io, but with a water ice-liquid outer shell of thickness between 80 and 170 km. Ganymede has a metallic core of radius 400–1,300 km surrounded by a rock mantle, which is in turn enclosed by an ice shell ~800 km thick. On the other hand, it is likely that the ice and rock-metal that make up Callisto have never completely separated. This work was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with NASA.

Abstracts to be submitted on or before December 15, 1999 to

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VUGRAPHS FOR EGS TALK, Nice, France,
24-29 April 2000

The Gravity Fields and Interior Structures of
the Galilean Satellites

Invited Talk Presented by John Anderson

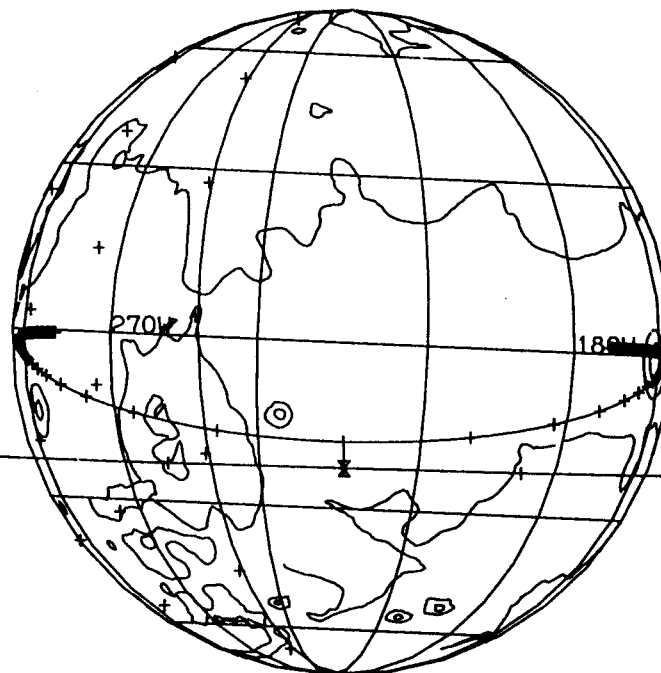
Authors: J.D. Anderson, G. Schubert, R.A.
Jacobson, E.L. Lau, W.B. Moore

Session: PS4, "The Jovian System and the
Galileo Mission"

IO 24: GROUNDTRACK AT CLOSEST APPROACH

SPACECRAFT TIME TICKS EVERY 2 MINUTES

ARROW 2 = SUN
ARROW 5 = EARTH
ARROW 13 = ECLIPTIC NORTH POLE
ARROW 16 = IO NORTH POLE



SIGNIFICANT EVENTS:

IO FLYBY (I24): 11-OCT-1999 04:35:55.7434 ET
PERIJOVE (PJ24): 11-OCT-1999 02:04:24.9657 ET

ET - UTC = 63.184 SEC AS OF 1-JUL-1997

IO FLYBY TIME (ET):
1999 Oct 11 04:35:56

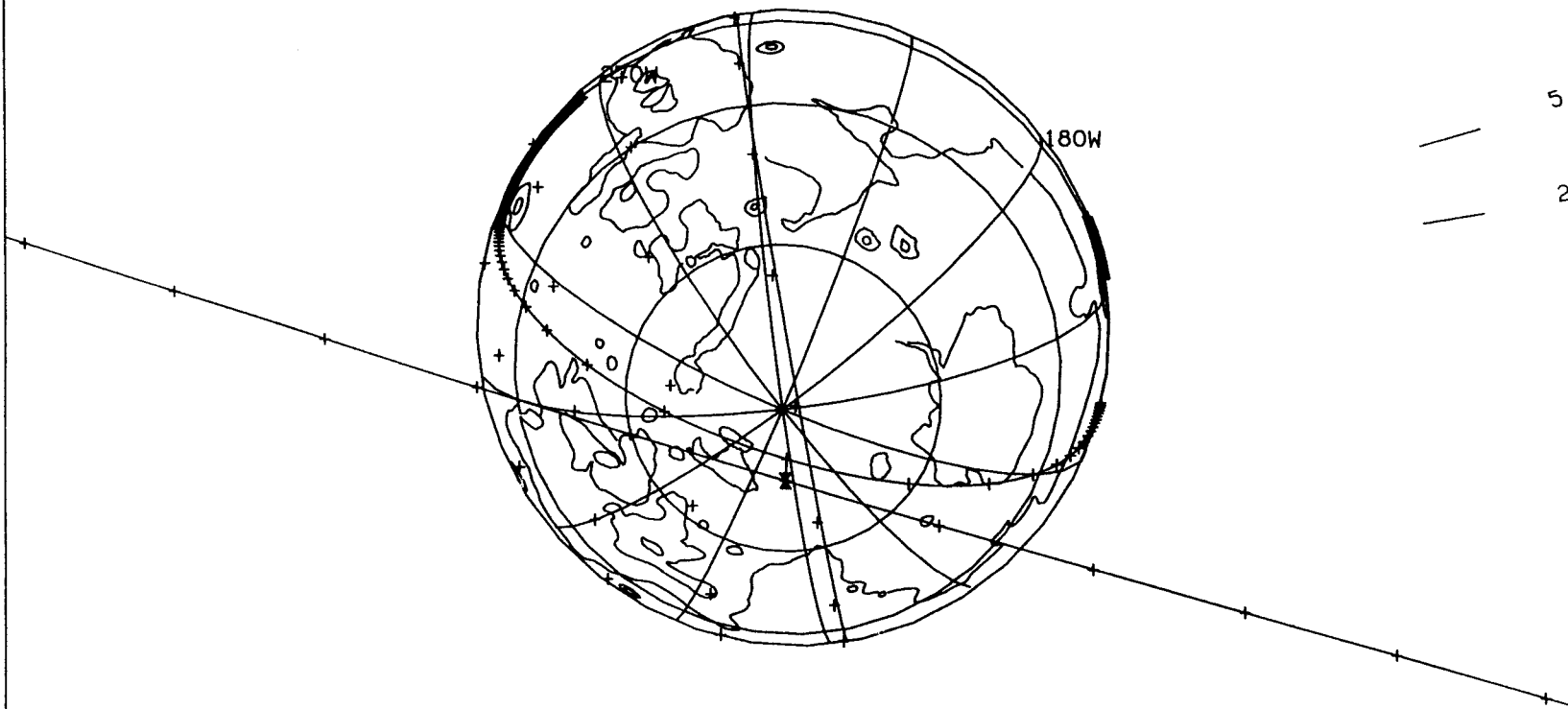
JLP Aug 11, 1997

IO 25: GROUNDTRACK AT CLOSEST APPROACH

SPACECRAFT TIME TICKS EVERY 2 MINUTES

ARROW 2 = SUN
 ARROW 5 = EARTH
 ARROW 13 = ECLIPTIC NORTH POLE
 ARROW 16 = IO NORTH POLE

13 /



SIGNIFICANT EVENTS:

IO FLYBY (I25): 26-NOV-1999 04:00:15.7622 ET
 PERIJOVE (PJ24): 26-NOV-1999 02:08:43.7432 ET

ET - UTC = 63.184 SEC AS OF 1-JUL-1997

IO FLYBY TIME (ET):

1999 Nov 26 04:00:16

JLP Aug 11, 1997

Exterior gravitational potential:

$$V = \frac{GM}{r} \left[1 - \frac{1}{2} J_2 \left(\frac{R}{r} \right)^2 (3 \sin^2 \phi - 1) + 3 C_{22} \left(\frac{R}{r} \right)^2 \cos^2 \phi \cos 2\lambda \right]$$

Physical interpretation:

$$C_{22} = \frac{B - A}{4MR^2} = \frac{3}{4} \alpha q_r$$

$$J_2 = \frac{C - (A + B)/2}{MR^2} = \frac{5}{2} \alpha q_r$$

Value of rotational parameter for Io:

$$q_r = \frac{\omega^2 R^3}{GM} = 0.0017123$$

Two independent gravitational parameters:

$$\alpha q_r = \frac{1}{5}J_2 + \frac{2}{3}C_{22} = (745 \pm 36) \times 10^{-6}$$

$$\epsilon = \frac{1}{5}J_2 - \frac{2}{3}C_{22} = 0$$

Normalized axial moment of inertia (from Radau–Darwin theory):

$$\frac{C}{MR^2} = \frac{2}{3} \left[1 - \frac{2}{5} \left(\frac{4 - 3\alpha}{1 + 3\alpha} \right)^{1/2} \right] = 0.378 \pm 0.008$$

Io Gravity Field

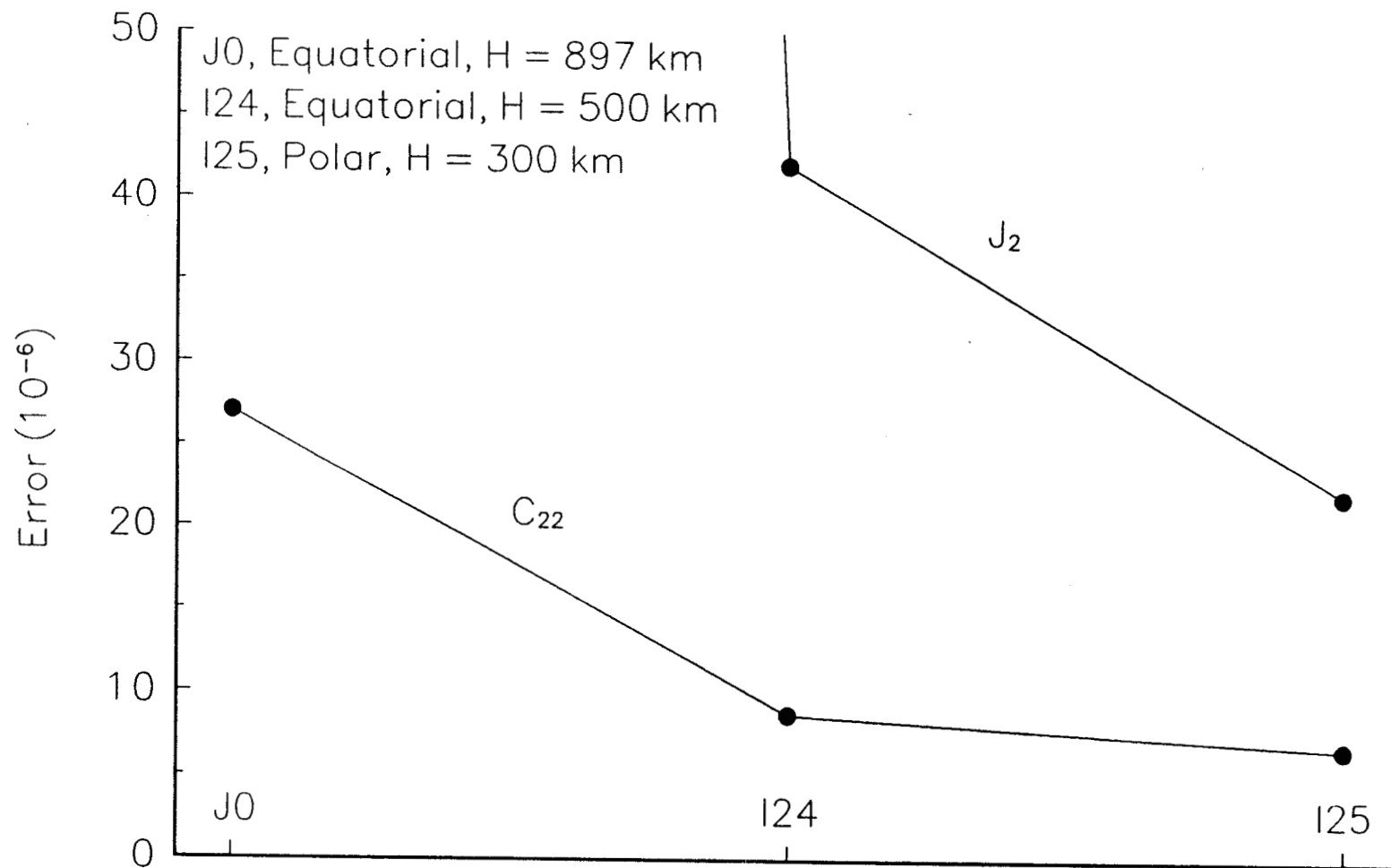
One-sigma values are in units of 10^{-6}

μ is the correlation coefficient

	JOI	JOI	I24	I25	I24/I25
Constrained?	Yes	No	No	No	No
σ_{J_2}	90	3300	34	17	8
$\sigma_{C_{22}}$	27	1000	3	16	3
μ	1.0	-0.703	-0.101	0.762	0.101

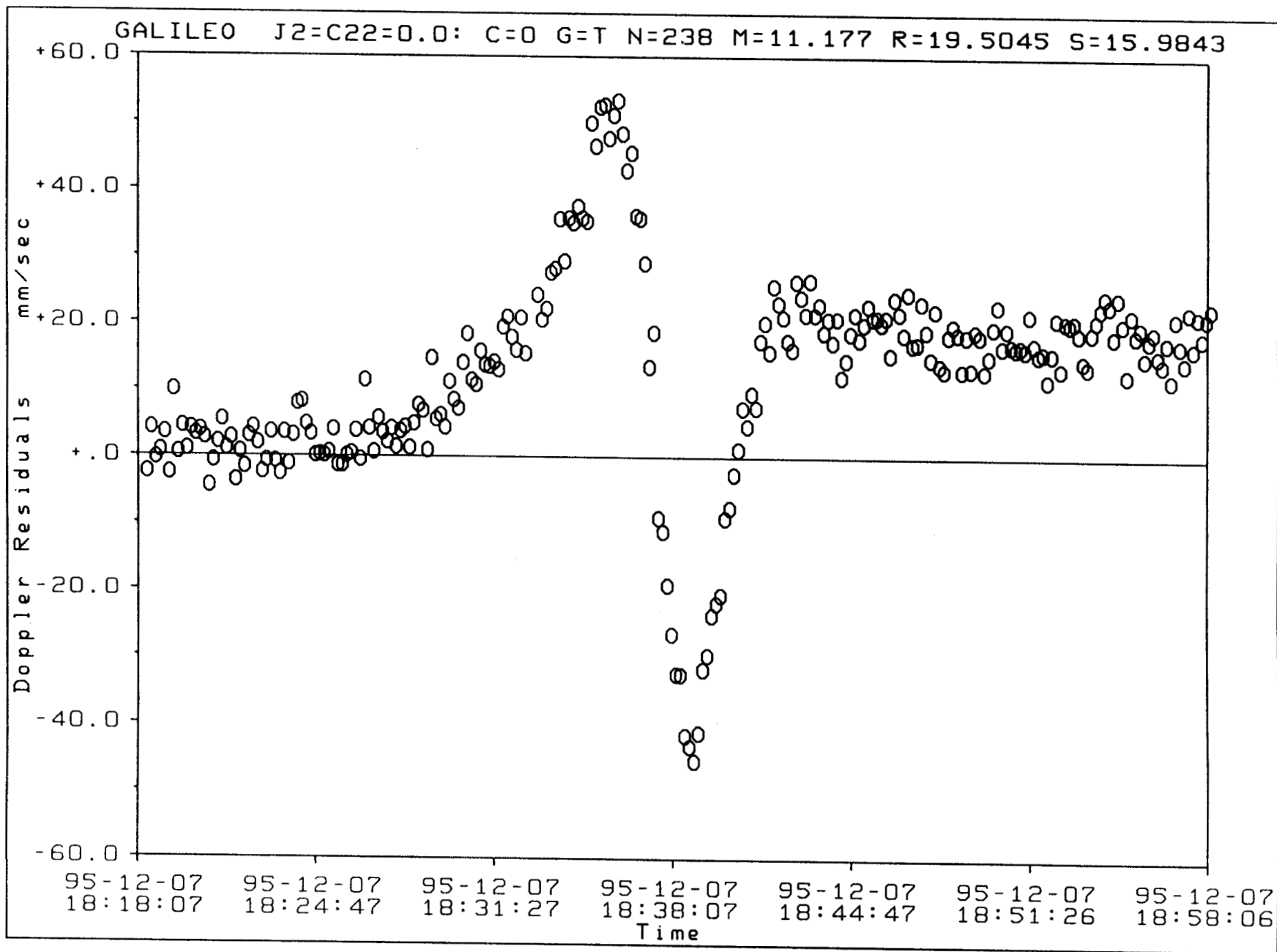
Predicted One-Sigma Error in Gravity Coefficients

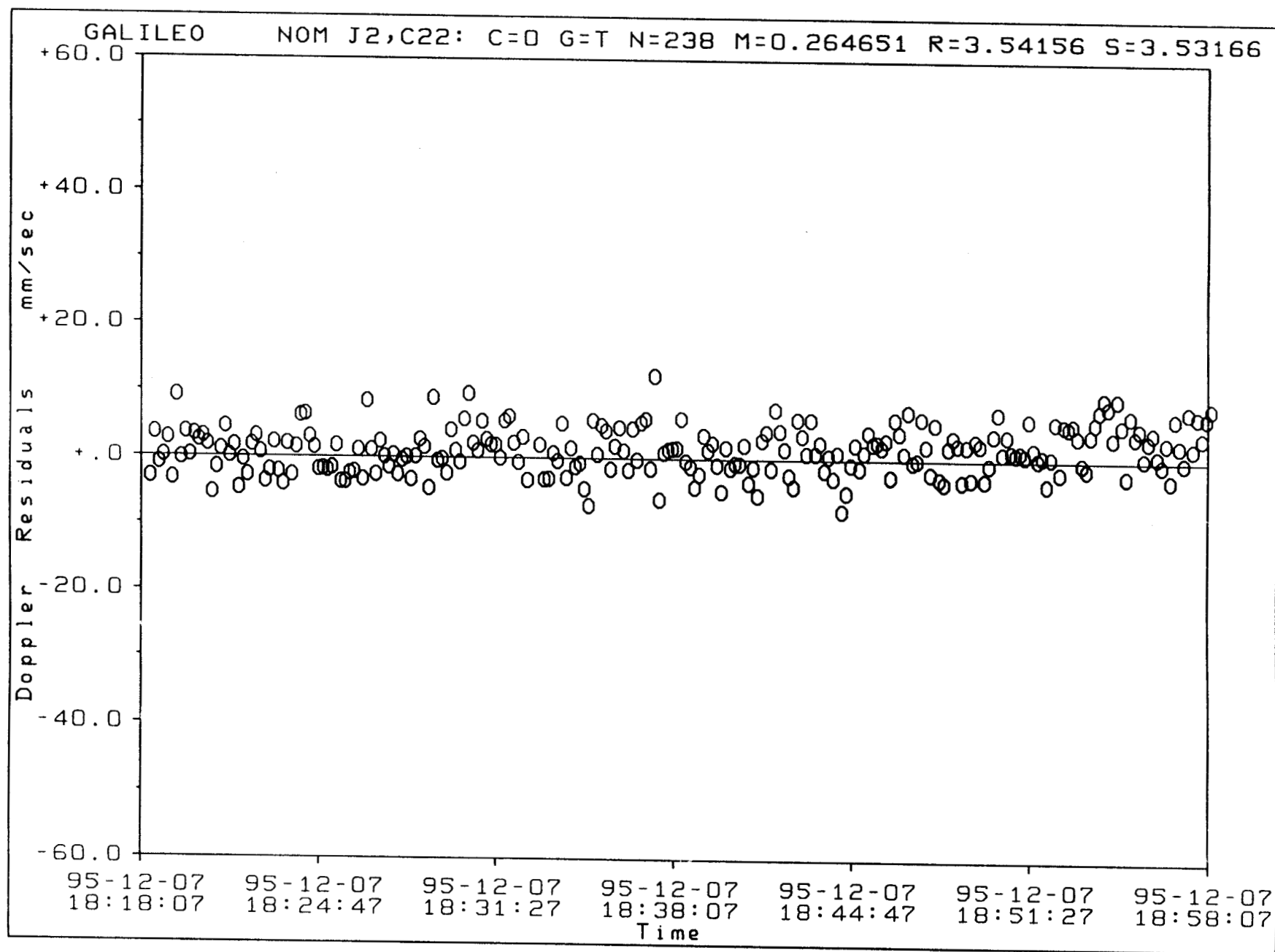
Assumes Coherent Doppler Plus and Minus 30 Minutes



Io Flyby

J.D. Anderson 7/15/97





Inferred Axial Moment of Inertia
Normalized to Mass Times Radius Squared (C/MR^2)

